NOTE FROM THE FIELD

Trauma-Related Psychophysiological Reactivity in Women Exposed to War-Zone Stress

Jessica Wolfe, Kelly R. Chrestman, Paige Crosby Ouimette, Danny Kaloupek, Rebecca M. Harley, and Maria Bucsela
Boston University School of Medicine

Women are at particular risk for Posttraumatic Stress Disorder (PTSD), but surprisingly little is known about their objective manifestations of the disorder's hallmark symptoms. Although research suggests that people with PTSD exhibit physiological reactivity to the presentation of trauma-related cues, the majority of studies to date have focused on men. We assessed the physiological reactions of three groups of trauma-exposed female Vietnam veterans (those with current PTSD, lifetime PTSD, or no PTSD) to war-related stimuli. Responses of women with current PTSD differed significantly from those without PTSD on skin conductance and systolic blood pressure, and mean levels of reactivity for women with lifetime PTSD fell between the other two groups. Although symptom severity was correlated with physiologic reactivity overall, results suggested differential relationships at the symptom cluster level. Study results replicate earlier findings with men and extend knowledge of autonomic reactivity to an important group of female survivors. © 2000 John Wiley & Sons, Inc. J Clin Psychol 56: 1371-1379, 2000.

Keywords: women; psychophysiology; veterans; traumatic stress

This research was supported by a Department of Veterans Affairs Medical Research Service Award to Jessica Wolfe. We gratefully acknowledge the assistance of Gretchen Clum, David Kamen, Rachel Kimerling, Karen Levin, Melanie Vielhauer, and Cecily Weisstein in the collection and processing of data. Darin Erickson provided valuable comments on an earlier draft of this article. We especially thank Joan Furey and the women Vietnam veterans who assisted us with their time and material for producing the study videotape.
Correspondence concerning this article should be sent to Dr. Jessica Wolfe, 30 Lowell Road, Wellesley, MA 02481; e-mail: jessicawolfe@mediaone.net.

Posttraumatic stress disorder (PTSD) poses a considerable problem for women: Recent U.S. comorbidity studies indicate that this disorder is twice as prevalent in women as in men (10.4% lifetime for women; 5.0% lifetime for men; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995) and that women are significantly more likely to suffer a chronic course (Breslau et al., 1998). Despite these data, surprisingly few studies have objectively characterized hallmark symptoms of the disorder in women. Because psychophysiological reactivity is described as a hallmark characteristic of PTSD (American Psychiatric Association, 1987, 1994), objective confirmation of reactivity in trauma-exposed women could help to better define the phenomenology of PTSD and explicate the conditions under which symptoms of physiological arousal arise or persist. The study of psychophysiological reactivity could also improve understanding of the relationship between objective disease manifestations and subjective symptom reports in particular groups (Blanchard, Kolb, Gerardi, Ryan, & Pallmeyer, 1986).

Most early studies of autonomic response to trauma stimuli were conducted with male combat veterans (e.g., Blanchard, Kolb, Pallmeyer, & Gerardi, 1982; Malloy, Fairbank, & Keane, 1983; Orr, Pitman, Lasko, & Herz, 1993; Pallmeyer, Blanchard, & Kolb, 1986). These studies employed either standardized or idiographic (i.e., individual, imaginal) trauma stimuli. Both formats have demonstrated that male veterans with PTSD show significantly greater physiological reactivity (heart rate, skin conductance) to trauma cues than matched male veteran controls without the disorder (Keane et al., 1998; Malloy et al., 1983; Pitman, Orr, Forgue, de Jong, & Claiborn, 1987).

Three studies to date reported on the psychophysiological reactivity of women with PTSD. Hearst, Wolfe, Furey, and Prins (1992) used both standard war-zone trauma stimuli and idiographic war trauma scripts and found increased heart rate responses in three well-characterized female Vietnam veterans with adult-onset PTSD. Shalev, Orr, and Pitman (1993) found that civilian women who developed PTSD following a variety of life traumas had greater physiologic reactivity to idiographic trauma scripts than did individuals without PTSD. More recently, Orr et al. (in press) assessed adult female survivors of child sexual abuse and found that women with moderate to severe current PTSD had significantly greater physiological reactivity than women with similar childhood experiences without this diagnosis.

It is now recognized that female veterans who serve in a war zone are at risk for exposure to significant stresses during their service (King, King, Gudanowski, & Vreven, 1995; Wolfe et al., 1998). However, the effects of these experiences are not well characterized (King, King, Gudanowski, & Foy, 1996; Wolfe, Brown, & Kelley, 1993). The present study was designed to extend the evidence of psychophysiological reactivity in PTSD by evaluating women who served in Vietnam. We examined the association between PTSD-related diagnostic and psychometric measures and well-established psychophysiological methods. A second aim was to determine whether lifetime PTSD in women was associated with lasting physiological impact given emerging evidence that psychophysiological reactivity can persist in men (Keane et al., 1998). To enhance comparability with earlier studies, we used a standardized audiovisual presentation of trauma cues (see Keane et al., 1998) with cues modified to reflect women's experiences during the Vietnam War.

Method

Participants

Thirty military veterans and six former service organization volunteers who experienced Vietnam war-zone trauma comprised the sample. These women volunteered for a larger study of cognitive processing, psycho-

physiological responding, and trauma (Ouimette, Wolfe, & Chrestman, 1996). Participants were identified through outreach to women veterans and veterans' service organization volunteers (e.g., American Red Cross, USO) via newspaper advertisements, mailings, speaking engagements, leaflets placed in VA hospitals and clinics, and word of mouth. Women were excluded if they were actively psychotic or had neurologic disease, or reported current substance abuse.

Average age at the time of service was 23 years (SD = 3.2). Modal duration of military service was two years (mean = 8; range = <1 to 30 years), and average time spent in Vietnam was 12.3 months (range = 1 to 22 months). Twenty-eight military veterans served as nurses or medical assistants whereas two were assigned to administrative or technical duties. Only one service organization volunteer served as a nurse during the war; the rest held social service or administrative positions, often traveling into dangerous areas. Participants' traumatic stressors ranged from direct rocket or mortar attack to extensive handling of dead or maimed bodies. All participants were Caucasian between the ages of 45 to 62 years (mean = 49.8 years; SD = 4.5). Forty percent were currently married and 45% were employed full time. Seventy-two percent had an undergraduate degree or had completed some graduate school.

Psychometric Instruments

Participants completed a demographic questionnaire, a battery of psychometric tests, and a structured diagnostic interview. Psychometric tests included the Women's Wartime Exposure Scale-Revised (WWES; Wolfe, Brown, Furey, & Levin, 1993). The WWES is a psychometrically sound, Likert-type scale comprised of 27 items that reflect four dimensions of women's traumatic wartime experiences; these range from military attack to severe gender discrimination or sexual assault. PTSD symptomatology was assessed using the Mississippi Scale for Combat-Related PTSD (MPTSD; Keane, Caddell, & Taylor, 1988), a valid and reliable 39-item, continuous measure assessing symptoms and associated features of the DSM-III-R PTSD in Vietnam veterans.

PTSD was assessed using the Clinician Administered PTSD Scale (CAPS; Blake et al., 1990), a widely used semistructured interview that assesses PTSD according to DSM-III-R criteria. The CAPS yields symptom scores for the three primary PTSD criteria obtained by summing individual responses for frequency and intensity. Prior research showed that this instrument has excellent psychometric properties and good concordance with a SCID diagnosis of PTSD (for review, see Blake et al., 1995).

Format and Apparatus

Audiovisual presentations were based on those used by Malloy et al. (1983) and later modified for a multisite study of male veterans (Keane et al., 1998). To obtain stimuli that were realistic for women, a panel of eight women who served in Vietnam assisted in identifying audiovisual material representative of women's wartime experiences. The final tape consisted of six photographic images prerecorded onto videotape with accompanying sound track that matched slide content. Images and sounds depicted a warzone evacuation and associated hospital procedures including explicit scenes of caretaking, treatment, death, and dying. For the neutral condition, we employed the tape used by Keane et al. (1998), which includes six outdoor snow scenes accompanied by light classical music. Technical details of the apparatus exactly matched those reported by Keane et al. (1998). Therefore, the description here is abbreviated.

Psychophysiological recording took place in a sound-attenuated room furnished with a comfortable armchair. Participants were monitored by a closed-circuit video and intercom.

Physiological dependent measures included heart rate (HR), skin conductance

(SC), and systolic and diastolic blood pressure (SBP, DBP). Computer software was custom designed to automate sampling of the physiological measures and control the timing and display of audiovisual presentations. It also generated rating scale displays and recorded rating values registered through a joy stick connected with the computer.

Procedures

Masters- and doctoral-level clinicians who had been thoroughly trained using detailed materials from the instruments' authors conducted all interviews. Next, technicians oriented participants to the laboratory equipment, attached electrodes and the blood pressure cuff, adjusted headphones, and placed the joystick within easy reach of the nondominant hand. Participants were instructed to sit quietly for 10 min. HR and SC were recorded during the final five minutes of the rest period (Baseline 1); blood pressure was sampled once at the end of the period. Each subsequent baseline followed this format.

Participants then listened to audiotaped study instructions and practiced using the joystick to make subjective unit of distress (SUD) ratings. When the participant had successfully mastered the joystick, each of the six neutral scenes was presented for one minute while HR and SC were recorded. SUD ratings were recorded during a 20-second period at the end of each scene. Blood pressure (BP) was recorded at the end of the final scene. A five-minute rest period (Baseline 2) followed the ratings for the final neutral scene. The combat audiovisual presentation followed Baseline 2. Physiological and SUD recordings were completed similar to the neutral scene presentations. Another five-minute rest period (Baseline 3) followed.

After electrodes were removed, each participant was debriefed about the study and then paid $100 for her participation. Participants were contacted within 48 hours following the protocol to evaluate any residual distress. No adverse events were reported, and all participants were treated in accordance with American Psychological Association guidelines.

Processing of Psychophysiological Data

Initially, we removed invalid readings using a computerized algorithm that specified allowable minimum (40 beats/minute) and maximum (140 beats/minute) values and successive readings within 24 beats/minute of each other (see Berntson, Quigley, Jang, & Boynsen, 1990). Readings were then averaged for 30-second blocks that comprised (a) the final two minutes of baseline, (b) each of the six minutes of neutral presentations, and (c) each of the six minutes of war-zone presentations. SC readings were scored for responses (SCRs) in 30-second blocks that matched those quantified for HR. Definition of an SCR required a minimum amplitude of .05 microsiemens reached within ten seconds of upward deflection. The highest amplitude SCR per interval was determined and recorded for subsequent analysis. BP values recorded at the end of the baseline and the two audiovisual presentation periods were used for analysis.

Baseline HR was calculated by averaging the four 30-second mean values from the final two minutes of the initial baseline period. SCR was calculated as the average maximum SCR amplitude from the four 30-seconds periods. BP values were based on the single reading from the end of the baseline recordings.

The psychophysiological reaction to trauma-relevant material was calculated by subtracting a value for the neutral presentation from a value representing the war-zone presentation. For HR, values in question were the highest 30-second means within each presentation type; values for SC reflected the highest amplitude SCRs within each presentation type. For SBP and DBP, the single recording at the end of each presentation period served as the basis for the reactivity calculation. The highest SUD rating of 6 for each presentation type was used to calculate the difference between war-zone and neutral presentations.

Data Analysis

Analysis first focused on physiological differences predicted between Current and Never PTSD groups. We then examined possible differences between the Lifetime PTSD group and the other two groups, differences not clearly examined by previous studies and for which there was a limited basis for a priori hypotheses. We expected that the Lifetime group would be intermediate between the other two groups. A series of one-way analyses of variance (ANOVA) followed by post-hoc pairwise comparisons were used to identify group differences via the least significant difference criteria (LSD) for Student's *t*. Effect sizes were estimated for all comparisons.

Results

Clinical Data

During the CAPS interview, all participants identified a specific experience related to their service in Vietnam that qualified as a traumatic stressor using DSM-III-R PTSD criteria. Eight participants met criteria for current war-related PTSD (PTSD-C). Eight women met criteria for lifetime war-related PTSD (PTSD-L). The remaining 20 did not meet PTSD criteria at any time and were classified as no PTSD (PTSD-N).

In terms of stressor severity, the PTSD-C group described significantly higher levels of war-zone stress on the WWES than the PTSD-N group (see Table 1). There were some significant group differences on psychological symptoms. PTSD-C participants had significantly more PTSD symptoms than either PTSD-L or PTSD-N groups. Also, results showed that the PTSD-C group had higher B (reexperiencing), C (avoidance/numbing), and D (hyperarousal) scores than the other two groups. Further, the PTSD-L group endorsed significantly more hyperarousal than the PTSD-N group. There were no other differences.

Psychophysiological Data

Initial baseline values and audiovisual response scores are shown in Table 2. Baseline HR, SCR, and BP did not differ across the three groups. However, women with current PTSD exhibited significantly greater physiological responding to trauma cues on two of the four measures (SCR and SBP) than the PTSD-N group. The PTSD-C group also had significantly higher SUD scores than either the PTSD-L or PTSD-N groups, indicating greater subjective distress for women

Table 1
Comparison of Psychometric and Diagnostic Data by PTSD Status

	PTSD Status								
	Current (n = 8)		Lifetime (n = 8)		Never (n = 20)				
Assessment Measures	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 33)	*p*	ETA^2
Women's Wartime Exposure Scale	41.3[a]	23.2	35.9[a,b]	10.8	24.9[b]	12.5	3.9	.030	.191
Mississippi Scale	118.4[a]	18.5	86.9[b]	25.5	65.3[b]	20.2	18.4	.001	.528
CAPS Total Severity	50.8[a]	18.7	26.3[b]	16.6	10.0[b]	12.1	22.2	.001	.569
CAPS Criterion B Severity	9.0[a]	6.5	3.9[b]	2.1	1.3[b]	1.8	14.8	.001	.507
CAPS Criterion C Severity	21.2[a]	7.8	10.5[b]	9.3	4.9[b]	8.4	10.5	.001	.386
CAPS Criterion D Severity	20.6[a]	7.1	11.9[b]	7.8	3.9[c]	5.0	19.5	.001	.541

Note. Means in the same row with different superscripts significantly differ.

Table 2
Comparison of Physiological Responses to War-Zone Stressors by PTSD Status

	PTSD Status								
	Current (n = 8)		Lifetime (n = 8)		Never (n = 20)				
Physiological Measures	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*(2, 33)	*p*	*ETA*^{2}
Baseline Level									
Heart Rate	72.0[a]	10.6	70.3[a]	5.9	68.6[a]	7.9	<1.0	n.s.	.039
Skin Conductance Response Amplitude	.06[a]	.1	.1[a]	.2	.05[a]	.1	<1.0	n.s.	.043
Sytstolic Blood Pressure	118.7[a]	16.3	122.8[a]	19.0	112.6[a]	10.1	<1.0	n.s.	.030
Diastolic Blood Pressure	70.6[a]	9.2	68.8[a]	9.6	66.2[a]	6.6	<1.0	n.s.	.046
Cued Response									
Heart Rate	3.2[a]	7.5	3.1[a]	5.3	.7[a]	3.9	<1.0	n.s.	.052
Skin Conductance Response Amplitude	.4[a]	.5	.3[a,b]	.3	.03[b]	.2	3.7	.03	.186
Systolic Blood Pressure	12.1[a]	10.6	7.2[a,b]	6.9	3.6[b]	6.6	3.3	.05	.182
Diastolic Blood Pressure	1.7[a]	5.1	2.3[a]	9.2	3.6[a]	4.7	<1.0	n.s.	.024
Subjective Units of Distress	76.3[a]	32.4	48.6[b]	31.0	38.2[b]	30.3	4.3	.02	.208

Note. Heart rate values reflect beats per minute, skin conductance values reflect microsiemens, and blood pressure values reflect millimeters of mercury pressure. Means in the same row with different superscripts significantly differ. *Df* varies from (2, 30) to (2, 33).

with current PTSD. As expected, SCR and SBP were positively correlated with Criterion "D" (hyperarousal) symptoms. HR, however, was not significantly associated with "D" symptoms. Criterion "B" (reexperiencing) symptoms were significantly correlated with HR. SCR, and SBP. In contrast, Criterion "C" correlated significantly with SCR responding only (see Table 3).

Discussion

The major finding of this study is that women with current PTSD showed significantly more psychological symptoms and greater psychophysiological responses under trauma-cued conditions than did women without the disorder. No group differences were found on physiological measures during resting base-

Table 3
Correlations of Physiological Responses to War-Zone Stressors with PTSD Symptom Severity

	PTSD Symptom Severity		
Physiological Measures	CAPS Criterion B	CAPS Criterion C	CAPS Criterion D
Heart Rate	.45**	.33	.30
Skin Conductance Response Amplitude	.49**	.39*	.43**
Systolic Blood Pressure	.44**	.29	.39*
Diastolic Blood Pressure	−.12	−.16	−.22

Note. All tests were two-tailed Pearson correlations.
*$p < .05$, **$p < .01$.

lines. These findings are consistent with studies showing differences in reactivity between groups of men with and without combat-related PTSD (e.g., Keane et al., 1998; Orr et al., 1993) and suggest that psychophysiological assessment is equally relevant to the PTSD status of war-zone-exposed women. Our data contribute to evidence that physiologic reactivity in PTSD is a reliable phenomenon across different populations and trauma types (Blanchard et al., 1996; Shalev et al., 1993). Correlational analyses, while confirming an overall relationship between symptom severity and reactivity, indicated differential associations between particular PTSD symptom clusters and certain physiologic measures. The possible link between certain hallmark symptoms and specific physiologic systems warrants further investigation.

Reliable differences in reaction to trauma cues were evident for skin conductance responses and systolic blood pressure but not heart rate. Orr et al. (in press), the only other study of which we are aware comparing women with and without PTSD, reported significant group differences for heart rate but not skin conductance. We examined sample characteristics for both studies and found clear similarities for both symptom severity (e.g., CAPS totals, Mississippi scores) and levels of physiological reactivity. However, individual parameters of reactivity may vary depending on the population under study (i.e., adult vs. childhood trauma) and the particular methodology employed (i.e., standardized vs. personalized cues).

Changes in heart rate reactivity in PTSD were not significant in this study. Although earlier studies have often reported significant differences in HR, Keane et al. (1998) suggested that those findings might reflect the greater functional impairment and symptom severity of participants. Our nonsignificant findings may be linked to participants' lower symptom severity and higher functioning because women in the present study were not recruited from patient populations, had not been recently hospitalized psychiatrically, and many were gainfully employed. Alternatively, our correlational analyses failed to suggest a clear relationship between HR and two of the three major PTSD symptom groups. Thus, it is possible that HR is of limited utility in our sample.

Inclusion of women with lifetime PTSD offers an opportunity to examine residual effects of this disorder in the absence of a diagnosis. We found that the physiological response of PTSD-L participants fell midway between the two other groups, a finding consistent with male veterans (e.g., Keane et al., 1998; also see Prins, Kaloupek, & Keane, 1995) and female survivors of childhood sexual abuse (Orr et al., in press). These findings suggest that, once it is established, conditioned physiological reactivity may persist, even if the PTSD diagnosis remits (McFarlane & Papa, 1992; Wolfe, Keane, Kaloupek, Mora, & Wine, 1993).

Although childhood trauma is recognized for its deleterious effects (Allen, Coyne, & Huntoon, 1998; Roesler & McKenzie, 1994), we believe that the current study is the first to objectively demonstrate long-term sequelae in women exposed to trauma as adults and who are otherwise well adjusted. Still, participants in our study could have experienced trauma outside of the war zone. Accordingly, we cannot be certain that their responding was free of influence from other sources of distress.

Another limitation of this study is its small sample size. The effect sizes we obtained lend support to our findings although our statistical power was low. Also, not all women were free of medication when tested, and differential use of medication across groups could have influenced our findings. Still, Orr et al. (in press) found that results did not change when those investigators controlled for medication. Finally, because of the sample size, we could not examine characteristics of individuals with PTSD who were not physiologically reactive during testing. Two investigative teams (Keane et al., 1998; Orr, in press) reported that notable subsets of their current and lifetime PTSD participants failed to show the anticipated reactivity during exposure (e.g., 34% and 58%,

respectively). Implications of residual reactivity following diagnostic remission and nonreactivity by some individuals with current PTSD require further study.

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